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Climate of the Past Discussions

Interactive comment on "Extracting Weather Information from a Plantation Document" *by* Gregory Burris et al.

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Comment Response

Gregory Burris

February 6, 2019

1 Referee 1

This paper appears to make a solid contribution to the historical climatology of the southern United States by explaining and making accessible the extensive weather and climate-related data of a historical document, the records of Stanley Plantation, Virginia. The paper explains the document's context, categories of observations, potential uses and weaknesses for climate and weather reconstruction; it provides two examples of how its records may be used to illustrate local climatic change between the period of observations (1816-42) and recent decades. It demonstrates the potential for further historical climatology based on plantation records.

1.1 Author Response

Thank you.

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1.2 Comments From Referees

Within my range of expertise, I would judge the submission as nearly publishable as is, but I would recommend minor revisions: -There are numerous minor grammatical and syntactical errors and passages that could be made more concise and less repetitive.

1.3 Author Response

We have cleaned up the grammar and tightened up the prose. Please let us know if it remains a problem.

1.4 Author's Changes in Manuscript

[Changes were scattered throughout the manuscript]

1.5 Comments From Referees

-In section 3.1.1, it is important to note that historical climatologists working in other regional contexts (particularly early modern Europe and China) have long dealt with issues of the objectivity and potential for quantification of descriptive weather observations and have developed methods to address them such as monthly and seasonal indices (for an overview, see Christian Pfister and Sam White, "Evidence from the Archives of Societies: Personal Documentary Sources," in The Palgrave Handbook of Climate History, ed. Sam White, Christian Pfister, and Franz Mauelshagen (London: Palgrave Macmillan UK, 2018), 49–65, $https://doi.org/10.1057/978-1-137-43020-5_5$).

Therefore, with regard to these weather descriptions, it may be more helpful for the

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Discussion paper

authors to discuss the particular strengths and weaknesses and the objectivity and subjectivity of these particular plantation records, rather than going over issues in personal weather descriptions in general.

1.6 Author Response

Thank you for bringing the Palgrave Handbook to our attention. It was invaluable for improving the manuscript. We now spend less time on the weather descriptions and point to White et al. (2018) for further reading. We focus more on the particulars of the document we are working on.

1.7 Author's Changes in Manuscript

Carter is a particularly good source because of his naval background. While serving as a young officer during the war of 1812, he would have learned to keep consistent and accurate records. While he did not immediately apply this skill set when he took over Shirley Plantation in 1816, by 1820, he was making consistent daily entries (White et al., 2018).

[...]

The bulk of observations (13,461) made at Shirley Plantation were about the weather. Most days had at least one weather observation, even on Sundays, when there typically was no agricultural work done on the plantation. There were often two weather observations per day. One observation would involve temperature. The other would involve cloud conditions and precipitation. Most temperature and precipitation observations were ordinal and subject to the observer's definitions. Working with this type of data has been thoroughly researched elsewhere (White et al., 2018). As mentioned earlier, Carter's observations are notable for their consistency and reliability. Not only

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Discussion paper

were the entries made daily, but they were generally made first thing in the morning with consistent language throughout the decades that are covered. In aggregate, these weather observations can be used to develop ordinal temperature indices and time series (White et al., 2018).

1.8 Comments From Referees

They may (although I wouldn't consider it necessary) also wish to propose a method for extracting objective and quantifiable information from the narrative descriptions in their records.

1.9 Author Response

Referee 2 made a similar suggestion, recommending that we construct a temperature index from the data. White et al. (2018) was very useful here as well. Because we have not performed the data validation expected for a seven–point "Pfister scale" temperature index, we constructed a three–point index modeled after the one designed by H. H. Lamb (also discussed in White et al. (2018)).

1.10 Author's Changes in Manuscript

A three-point temperature index was created for the 1820–1842 period. This style of temperature index was first developed by H. H. Lamb (White et al., 2018). It organizes ordinal descriptions from historical records onto a three point scale. Cold conditions are given a negative value, hot conditions are given a positive value, and neutral conditions were given the value. Christian Pfister expanded on the method to create a seven–point index. However, the seven–point method requires a second dataset to validate the indexed data by. Since this is not yet available for the study region, we will be using

the three–point index here (White et al., 2018). This, combined with the rest of section 5 should accomplish this task.

Ordinal descriptions of temperature were organized into three categories: hot, neutral, and cold. Table 1 shows how the categorical temperature values were broken down into the three–point index. There were 12 values assigned to hot, 13 values were assigned to neutral, and 29 were assigned to cold. A rolling mean was taken for each day using the values for the 30 days surrounding it (the day's value, as well as the previous 15 days, and the 15 days after it). Figure 1 shows the index covering 1820–1842. The rolling mean allows the data to be smoothed without losing its daily resolution. The index is inline with with what we expected. The temperature index is at its highest during the summer months and lowest during the winter. The temperature index data is available at https://github.com/gdb12/Historical-bioclimatology.

1.11 Comments From Referees

-While the article does mention changing agricultural practices at Stanley Plantation (p.5, lines 15-25), the authors could do more to contextualize and emphasize the magnitude of agricultural experimentation and changes in land use in Virginia at this time, under pressure from changing markets, declining soil fertility, and new notions of agricultural "improvement." This history is discussed in more detail in another close examination of long-term Virginia plantation records (although not for purposes of historical climatology): Lynn Nelson, Pharsalia: An Environmental Biography of a Southern Plantation, 1780-1880 (University of Georgia Press, 2007). I was surprised not to see this publication in the works cited, and I believe it would be helpful for this project.

In this regard, or in section 4.2, the authors should also indicate (if possible) whether changing agricultural practices including the introduction of new cultivars appear to create artificial breaks or inhomogeneities in the timing of plant phenological observations.

1.12 Author Response

There was lot of experimentation on Shirley Plantation, including, soil treatments and new cultivars. Fortunately, these were well documented, and there were a few main cultivars that were always grown. These main cultivars can be used to create a homogeneous record, as well as allowing us to test for inhomogeneities in the expiremetal cultivars. The result is a consistent and homogeneous core of data, with experimentation being supplemental to this. The discussion was expanded to include this, and references to Nelson were added. We also added a discussion of the experimentation and changes in crops during this period to ensure that readers are aware of the possible complications.

1.13 Author's Changes in Manuscript

It is important note that this was a period of agricultural change and experimentation in Virginia, and Hill Carter participated heavily in these experiments (Nelson, 2007; Olmstead and Rhode, 2008b; White et al., 2018). Fortunately, he was also assiduous in documenting these efforts. He was careful to specify when he was fallowing and which fields he was doing it to. He experimented with several fertilizers and soil treatments to address soil erosion and degradation, and experimented with many cultivars. He documented when and where these experiments were conducted. He also noted when he tried new cultivars. Throughout his experiments, he used a few main cultivars every year. While the use of the various cultivars may have resulted in inhomogeneities in the plant-phenological records, there is a consistent reference variety that these can be compared to (White et al., 2018).

[...]

Tracking the cultivar is especially useful for the nineteenth century. New cultivars were developed, experimented on, and further selected for specific traits. These efforts

resulted in significant modification of the phenological and morphological traits in the crops. These modifications probably resulted in many of the crop yield gains seen in the antebellum period, as well as the expansion of the ranges of many crop species (Olmstead and Rhode, 2008a, b, 2018).

1.14 Comments From Referees

-The authors mention crop pests in section 4.1: does the presence of any of these also indicate specific climate conditions (similar to malaria, as discussed in the article)? If they do, it's worth mentioning; but if not, I don't recommend any changes.

1.15 Author Response

There are several types of pests that are sensitive to climate variation. We included a discussion of these in the new discussion in section 3. There is potential here, but it will take additional research to realize. These are now included in the discussion of the types of data available in the document we are working on.

1.16 Author's Changes in Manuscript

Hill Carter's plantation document records many types of observations including, but not limited to, a weather diary, plant-phenology observations, ice-phenology observations, and the phenologies of other species that are responsive to climate variation. These other phenologies include fungus, nematodes, insects, and disease causing parasites. These often came in the form of crop pests, like wheat rust, cockle, and Hessian Fly, as well as well public health factors that we now know as *Anopheles* mosquitoes and *Plasmodium vivax*.

1.17 Comments From Referees

-The authors may save a few lines in the discussion of challenges in early thermometer readings in section 4.5 by citing to Dario Camuffo, “Evidence from the Archives of Societies: Early Instrumental Observations,” in The Palgrave Handbook of Climate History, ed. Sam White, Christian Pfister, and Franz Mauelshagen (London: Palgrave Macmillan UK, 2018), 83–92, $https://doi.org/10.1057/978-1-137-43020-5_7$ and Ingeborg Auer, “Analysis and Interpretation: Homogenization of Instrumental Data,” in The Palgrave Handbook of Climate History, ed. Sam White, Christian Pfister, and Franz Mauelshagen (London: Palgrave Macmillan UK, 2018), 99–105, $https://doi.org/10.1057/978-1-137-43020-5_9$, which already summarize these issues. I offer this only as a suggestion.

1.18 Author Response

this section was shortened and reference given to the Palgrave Handbook. The section now focusses on the particulars of Shirley Plantation’s instrumental records.

1.19 Author’s Changes in Manuscript

There were limits to the precision of the instrument itself. Without knowing the details of its manufacture, it is not possible to tell how big of a measurement error there may or may not have been. The placement of the instrument, such as in the shade or direct sunlight, could also affect readings. There could be a systematic bias in how the observer was reading the instrument, such as if the mercury or alcohol in the instrument was between two ticks, the observer might always round it up or down. It is also possible for the observer to read the instrument differently from day to day, or for their method to change over time. The documenting of observations throughout the year

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Discussion paper

was also inconsistent. The observer might only remember to document the temperature when it is especially cold or hot. They might also forget to make the entry if they are especially busy. This can be random, or systematic. During the calving season each year, when the observer is working long and irregular hours, they might forget to enter the temperature. They might also think to make an entry in response to extreme weather events when they would not have usually remembered to. There can also be more traditional inhomogeneities in the entries. If the instrument is moved to a different location or height, a systematic bias can be introduced from suddenly being in direct sunlight or being closer to the ground. For a more detailed discussion of early instrumental records, see White et al. (2018).

1.20 Comments From Referees

-In general, I would like to see some verification of the accuracy and consistency of the climate information provided in the plantation documentation, or a suggestion how it might be verified. This verification could come from examination of its internal consistency: e.g., do variations in weather descriptions match variations in the timing of plant phenological observations? Or it could come from comparison with external information: e.g., does the Stanley Plantation document appear to consistently match other nearby records of climate or weather variability (e.g., stories about weather in a local newspaper, or descriptions of seasons in a local history) or well-observed extreme events that affected the region (e.g., the unusual winter of 1827-28 discussed in Cary J. Mock et al., "The Winter of 1827–1828 over Eastern North America: A Season of Extraordinary Climatic Anomalies, Societal Impacts, and False Spring," Climatic Change 83 (2007): 87–115, https://doi.org/10.1007/s10584-006-9126-2.)? In other words, even if the document does not provide a complete record of weather variability, is there a way to see if serves at least as a consistent high-pass filter for major variations and extremes? Even if the authors do not provide such verification here (and I do not regard it as essential for publication of this manuscript) could they suggest how it

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Discussion paper

may be done in the case of this and other plantation records? That could be helpful for future research.

1.21 Author Response

We feel that data validation is the topic of my next paper and is a subject large enough for its own publication. We added a section on this to our section on future work. We discuss our plans for data calibration and validation. We intend to test to see if large climate phenomena like ENSO is detectable in the data. Once an appropriate dataset is found, we will also calibrate and validate more sophisticated calibrations.

1.22 Author's Changes in Manuscript

Future work will focus on validating the data, expanding the database, and producing an in-depth analysis of the climate of Virginia. The most immediate concern will be data validation and calibration. We will test to see how well the data captures large scale climate phenomena like ENSO, tropical cyclone activity, and the aftermath of the Mount Tambora eruption. Calibration has proven to be more elusive. While there are a few thermometer observations in the data, they are too rare to be used for calibration. None of the local newspapers published temperature records for this period either. However, once additional plantation records from other nearby plantations, such as Berkeley Plantation (6 miles southeast of Shirley Plantation) will allow for content analysis validation (Moodie and Catchpole, 1976). Thomas Jefferson's temperature observations offer another possible dataset for validation and calibration. During his tenure as ambassador to France, Jefferson confirmed that his own thermometer was consistent with the official instrumental records in France, and maintained twice daily instrumental and ordinal weather observations during his four year residency there. this will allow us to calibrate North American records to its European contemporaries,

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Discussion paper

and validate other North American temperature records. Jefferson's own plantation records, from his garden book, have already been extracted to a database by our team (Jefferson and Baron, 1987. Work has begun on extracting Jefferson's temperature records, including his time in Paris, France (Jefferson, 1776).

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2 New Figure and table

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Fig. 1. Three-point temperature index for the period 1816–1842. See text for discussion of how the index was constructed.

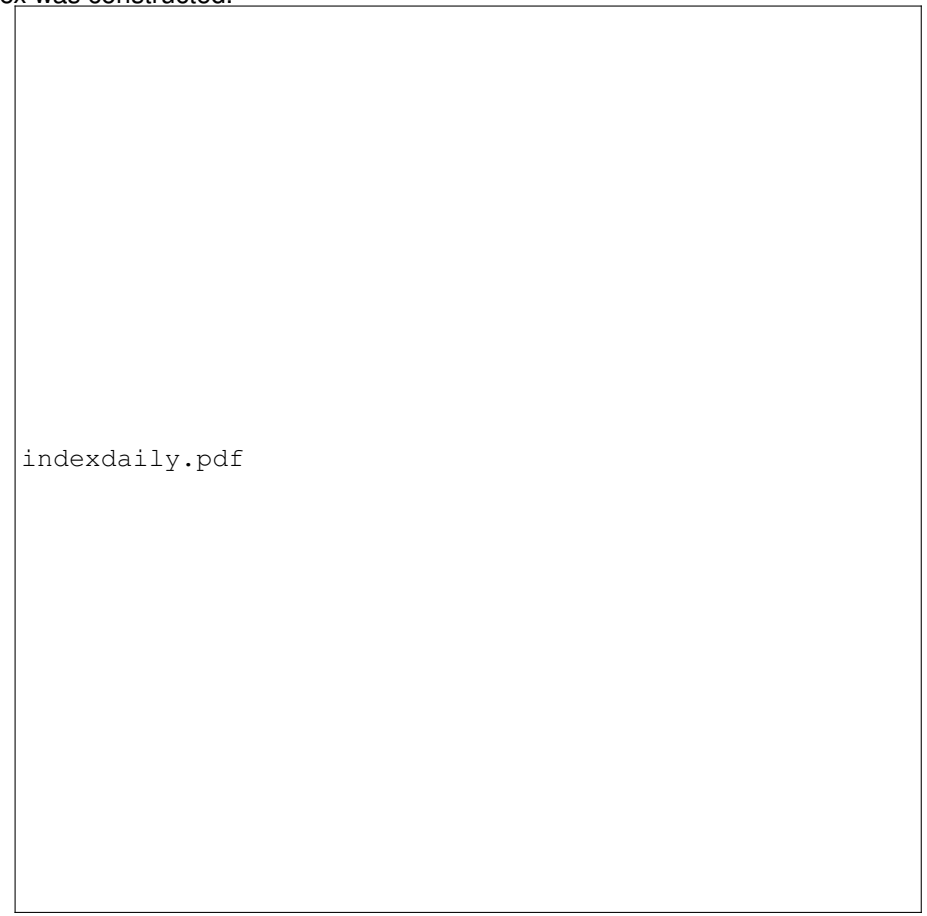

Table 1. Temperature index Categories.

Hot	Neutral	Cold
exceptionaly hot	fair	below freezing
excessively hot	fine	cold
hot	mild	cool
hotest day this year	mild and pleasant	exceedingly cold
hotest morning this year	milder	excessively cold
indian summer	mildest winter ever known this far	excessively cold for season
sultry	moderate	first frost
very hot	nice	freeze
very warm	pleasant	frost
very warm for season	very mild	frost very slight
violently hot	warm	frozen
workers fainted from heat	warm and pleasant	ground frozen
	warmer	ice
		light frost
		river frozen
		river hard frozen
		river nearly frozen
		second frost
		severe frost
		severe white frost
		severest frost yet
		smart frost
		turned colder
		turning cold
		very cold
		very cold violent change
		very cool
		white frost
		wintery